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B459 B45X B489 B519

B539 B549 B559 B610

B611 B613 B616 B619

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(56) Documents cited

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(58) Field of search

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(54) Silver-copper-germanium Alloys
Having High Oxidation Resistant
Melts

(57) A silver-copper-germanium base
alloy is disclosed consisting by weight
of 40 to 85% silver, 15 to 60% copper
and 0.1 to 10% germanium.

Optionally, up to 15% by weight of

the base alloy may be replaced with
tin and up to 10% by weight of at least
one of gold, palladium and platinum.

The presence of germanium in the
alloy virtually eliminates oxidation of
the melt during the melting and
casting of the alloy and thereby also
improves resistance to tarnishing
when the alloy is used in an oral
environment.

SPECIFICATION

Silver-Copper-Germanium Alloys Having High Oxidation Resistant Melts

The present invention relates to alloys which are composed essentially of silver, copper, and germanium, such combination hereinafter referred to as the base alloy, and optionally to the base alloys containing tin and varying amounts of precious metals, as for example, gold, palladium and platinum.

Conventional cast wrought dental alloys, such as those used for inlays, crowns, bridges, and partial dentures, usually contain over 45% by weight of at least one of the precious metals: gold, palladium and platinum, which impart to the alloy the properties of high toughness, the ability to be easily fabricated and good corrosion resistance. Because of the high precious metal content in these types of alloys, the costs of preparing these alloys due to the present high cost of the metals is becoming exorbitant; thus one of the objects of the present invention is to provide new compositions of dental alloys which contain either no precious metals or which have a much lower amount of the precious metals than conventional alloys.

The term "precious metal" as used herein is applicable to gold, palladium and platinum only or to combinations of two or all of these metals.

The base alloys of silver-copper-germanium of this present concept exhibit excellent casting properties as well as ease of fabricating, a hardness that increases with solidification rate and virtually no tendency to oxidation in the liquid state. The base alloys of the present invention have been found to generally have fair corrosion resistance and properties which are desirable for some types of cast alloys employed in dentistry.

I have found that the addition of small to moderate amounts of germanium to silver-copper alloys to produce the present base alloy virtually eliminates oxidation of the melt during the melting and casting of the alloy and furthermore the presence of germanium markedly improves the castability of the alloy. In addition, the silver-copper alloys containing germanium, exhibit an improved resistance to tarnishing in an oral environment. These beneficial results due to germanium are obtained with little or no loss of the excellent fabricating characteristic of silver-copper alloys, when the amount of germanium does not exceed ten percent.

Thus, in accordance with the present invention a base alloy of silver-copper-germanium is provided consisting essentially of, by weight, 40 to 85% silver, 15 to 60% copper and 0.1 to 10% germanium, the base alloy of silver-copper-germanium optionally being replaced up to 15% by weight of tin and up to 10% by weight of at least one of the precious metals consisting of gold, palladium and platinum.

The beneficial effects of germanium additions to the silver-copper alloys are noticeable even in concentrations as low as 0.1% by weight; however the preferred amount of germanium which is present in the alloy is in the range of 0.5% to 2% by weight of alloys which are rich in silver and up to 10% by weight of germanium for alloys which are rich in copper. The addition of the germanium does not significantly affect toughness nor the working ability of the alloy. One of the main beneficial effects imparted to silver-copper alloys by the addition of germanium is that virtual elimination of oxidation of the alloy is obtained during melting and casting. The protection against oxidation of copper in the alloy results from the preferred oxidation of germanium and the simultaneous sublimation of the germanium oxide (GeO) as it forms. At approximately 710°C , solid germanium oxide transforms directly to the gaseous state at one atmosphere pressure, the pressure vapour increasing exponentially with temperature. Eutectic or near-eutectic silver-copper alloys which would correspond to approximately 72 parts of silver to 28 parts copper by weight, melt at a temperature of approximately 780°C . Any oxygen penetrating the alloy melt containing germanium is immediately and vigorously expelled as gaseous germanium oxide at a pressure considerably exceeding one atmosphere. Furthermore, as a result of the sublimation process, a protective blanket of gaseous germanium oxide is formed which prevents or significantly decreases the amount of atmospheric oxygen from reaching the surface of the melt. The result is a virtually oxide-free casting when germanium is present which is in direct contrast to the black oxide surface that invariably develops during the melting and casting of silver-copper alloys which contain no germanium.

The excellent casting ability of the silver-copper-germanium alloys of the present invention is believed due to the virtual absence of any oxide films on the melt surface and also due to the high surface tension as indicated by the tendency of the alloy melt to ball or spheroidize. The high surface tension of the alloy melt is associated with the vaporization of the germanium oxide at the melt-air interface. In general, an increase in surface tension of a melt results in a corresponding decrease in the tendency of the melt to wet surfaces which improves flow and thereby improves the casting ability of the alloy.

The hardness of the base alloy of silver-copper-germanium composition of the present invention, in particular the preferred alloy in which the silver-copper weight ratio corresponds to the eutectic or near eutectic composition, is directly related to the fineness of the microstructure of an alloy which may be varied from a relatively coarse to an extremely fine lamellar-like structure by increasing the solidification rate of the alloy casting. I have found that for rapid solidification rates and correspondingly

	Alloy	Composition Weight %	Hardness Vickers	Colour	
5	Y-10	Silver 71.1 Copper 27.6 Germanium 1.3 100.0	195	White Gold	5
10	Y-15	Silver 87.7 Copper 26.3 Gold 4.8 Germanium 1.2 100.0	170	White Gold	10
15	Y-14	Silver 61.9 Copper 24.1 Tin 12.3 Germanium 1.7 100.0	240	Silver	15
20	Y-25	Silver 63.9 Copper 24.9 Gold 9.9 Germanium 1.3 100.0	145	White Gold	20
25	Y-20	Silver 67.6 Copper 26.2 Palladium 5.0 Germanium 1.2 100.0	130	White Gold	25
30	Y-18	Silver 64.7 Copper 25.2 Tin 6.2 Gold 2.4 Germanium 1.5 100.0	185	Light Gold	30

35 In preparing the base alloy of silver-copper-germanium, the germanium may be incorporated into the alloy by one of several methods. It may be added to the alloy melt directly in an essentially pure state or it may be added in the form of an eutectic silver-germanium master alloy containing about 19% germanium by weight. The finished base alloys may be provided in several forms, as for example, rods, sheet, strip, castings, shot, powder or compressed powder tablets. In the powder form, the germanium may be incorporated into the alloy prior to the powdering stage, or it may be admixed as a constituent powder of pure germanium or of a germanium-base alloy into the alloy powders
40 constituting the remaining alloying components. 40

While the invention has been described with reference to certain specific examples and compositions, it is not necessarily confined to the details as set forth and this application is intended to cover modifications or changes as may come within the scope of the following claims.

Claims

- 45 1. A base alloy of silver-copper-germanium consisting essentially of 40 to 85% by weight silver, 15 to 60% by weight copper and 0.1 to 10% by weight germanium. 45
2. An alloy according to claim 1 consisting essentially of 70 to 72% by weight silver, 26 to 28% by weight copper and 0.5 to 2% by weight germanium.
- 50 3. A base alloy of silver-copper-germanium consisting essentially of 40 to 85% by weight silver, 15 to 60% by weight copper and 0.1 to 10% by weight germanium, said base alloy being replaced by up to 15% by weight tin. 50

4. An alloy according to claim 3 consisting essentially of 60 to 66% by weight silver, 22 to 27% by weight copper, 0.5 to 2% by weight germanium, and 10 to 15% by weight tin.
5. A base alloy of silver-copper-germanium consisting essentially of 40 to 85% by weight silver, 15 to 60% by weight copper, 0.1 to 10% by weight germanium, said base alloy of silver-copper-germanium being replaced by up to 10% by weight of at least one precious metal selected from the group consisting of gold, palladium and platinum. 5
6. An alloy according to claim 5 consisting essentially of 62 to 70% by weight silver, 24 to 27% by weight copper, 0.5 to 2% by weight germanium and up to 10% by weight gold.
7. A base alloy of silver-copper-germanium consisting essentially of 40 to 85% by weight silver, 15 to 60% by weight copper, 0.1 to 10% by weight germanium, said base alloy being replaced by up to 15% by weight tin and by up to 10% by weight of at least one precious metal selected from the group consisting of gold, palladium and platinum. 10
8. An alloy according to claim 7 consisting essentially of 55 to 65% by weight silver, 20 to 25% by weight copper, 5 to 15% by weight tin, 3 to 7% by weight gold, and 0.5 to 2% by weight germanium. 15
9. A base alloy of silver-copper-germanium substantially as herein described.